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Systematic affinity of *Acroporella assurbanipali* Elliott (Dasycladaceae), with notes on the genus *Neomeris*

FILIPPO BARATTOLO & ROBERTA ROMANO

Dipartimento di Scienze della Terra, Università degli Studi di Napoli Federico II, Largo San Marcellino 10, 80138 Napoli, Italy

Synopsis. The holotype of the extinct Dasycladacean alga *Acroporella assurbanipali* Elliott is re-described and a reconstruction is presented. The status of the species is reviewed, and it is assigned to the genus *Neomeris*, subgenus *Larvaria*.

INTRODUCTION

This paper deals with the systematic affinity of the Lower Cretaceous alga *Acroporella assurbanipali*, which is known only from the type-locality at Erbil Liwa, Iran. We present a new description based on a reinterpretation of the holotype, which is deposited in the Natural History Musem, London (Elliott collection). *A. assurbanipali* is reassigned to the genus *Neomeris*, subgenus *Larvaria*. The taxonomic status of *Acroporella* and *Neomeris* is also discussed.

ACROPORELLA ASSURBANIPALI AND ITS RELATIONSHIP WITH THE GENUS *ACROPORELLA* (PRATURLON) EMEND. PRATURLON & RADOICIC

The genus *Acroporella* was established by Praturlon in 1964 and based on algal specimens from Upper Jurassic – Lower Cretaceous shelf limestones of the Central Apennines (Marsica, Central Italy). In that paper, Praturlon characterized the genus as simple thallus, with euspondyle and acrophorous primary laterals (= branches), and probably endosporous. The type species *Acroporella radoicici* has the following characters: cylindrical, not segmented dasycladaceae; branches acrophorous, simple, oblique to axis (15–45° on the horizontal), arranged in euspondyle alternating whorls; calcification reaching the axial cell; dimensions in mm (between brackets the extreme value): D=0.55 (0.36–0.70); d=0.25 (0.17–0.33); p=0.06 (0.05–0.07); w=8–12; h=0.1 (0.085–0.11); maximum measured length of the fragments=5.4; reproductive organs unknown.

Praturlon & Radoicic (1974), following the rules of the International Code of Botanical Nomenclature, changed the epithet from *A. raidoicici* to *A. radoicicae*. Moreover, on the basis of better preserved Barremian-Aptian material from Dinarides, they showed that the species bears four short secondary laterals per primary lateral set distally. Accordingly they proposed an emendation of the genus and gave the following diagnosis for *Acroporella:* 'Cylindrical, not segmented dasycladaceae, having whorls of primary branches distally ramified in clusters of button-like secondary twigs'.

However six years before the emendation by Praturlon & Radoicic (1974), Elliott had established the species *A. assurbanipali* from the Lower Cretaceus of Erbil Liwa, Iran. According to Elliott (1968) the species is characterised by: 'Cylindrical tubular calcified dasyclad, external diameter 1.36 mm, internal diameter 0.55 mm (40% of external); successive near-horizontal verticils, probably 3 or 4 per mm of tube-length, of perhaps twelve radial branches each. The single branches communicate with the stem cavity by a pore of about 0.052 mm diameter: they then swell out to a fig- or flask-shaped cavity of 0.182 mm maximum diameter, narrow to a slightly curved tube of 0.078 mm diameter, and then at the outer surface flare out to a shallow terminal diameter of 0.156 mm'.

Since its proposal, *A. assurbanipali* has been overlooked by most authors. Granier & Deloffre (1993) re-assessed its taxonomic position and confirmed the affinity with *Acroporella*, but with reservations. One of the authors of the present paper (F. Barattolo) recently examined the Elliott collection at the Natural History Museum, London. Re-examination of the single specimen in thin section (holotype) and Elliott's description, allows us to propose a new interpretation of the anatomy of the alga. Accordingly, we assign the species to the genus *Neomeris*.

NEOMERIS (LAMOUROUX, 1816), ITS SUBGENERA AND ALLIED GENERA

The genus was defined on an extant species from Jamaica (*Neomeris dumetosa* Lamouroux).

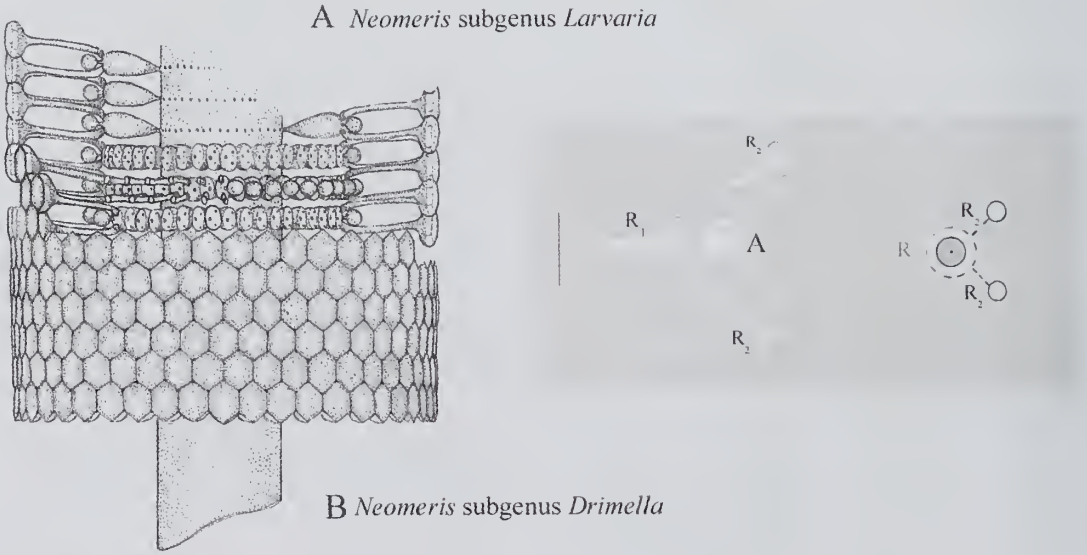
The alga is characterised by a cylindrical thallus bearing whorls of primary laterals. Each primary lateral bears at its outer end a single ovoid ampulla together with two secondary laterals. The laterals, usually those of secondary order, may produce a cortical layer (Valet, 1968; Berger & Kaever, 1992).

Seven species are known to live in tropical and subtropical seas where they populate protected microenvironments of the reef platform (Valet, 1979), in moderately exposed environments (e.g. *Neomeris mucosa*) and in tidal pools (e.g. *Neomeris cokeri*) (Taylor, 1972). According to Konishi & Epis (1962) a depth of 0–10 m and a temperature of 15–20°C are their optimal environmental conditions.

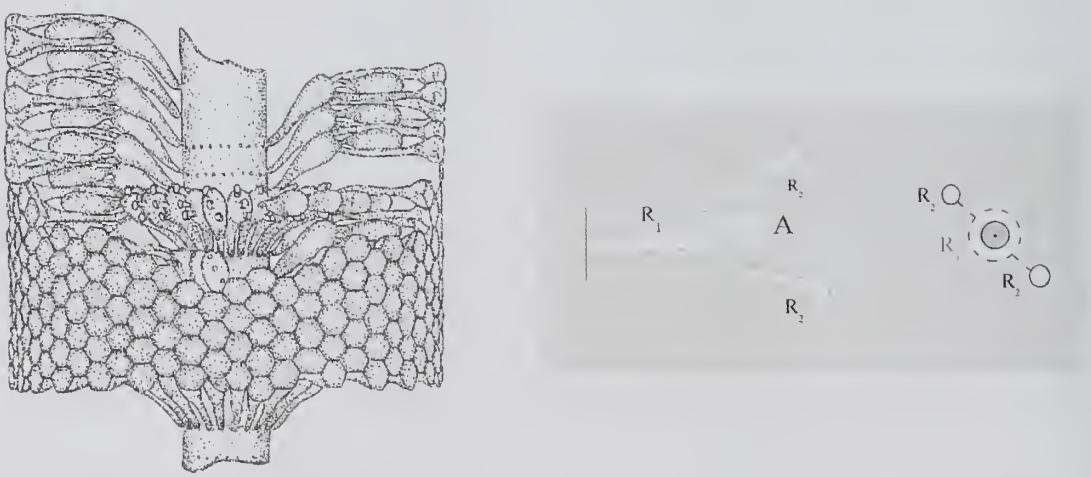
The main diagnostic characters utilised in botanical description of specific rank in extant *Neomeris* are: shape of primary laterals; shape of secondary laterals and their distal ends making a cortex or not; shape of fertile ampulla and cyst; shape of the plug set at the connection between primary laterals and ampulla; calcification (Génot, 1980).

In spite of its modest role in the modern marine environment, the genus *Neomeris* is well represented in the fossil record, but incomplete calcification does not allow observation of some characters that are useful for classification. The earliest occurrence of the genus (*Neomeris cretacea*) is in the Albian of Orizaba (Mexico; Barattolo, 1987).

A *Neomeris* subgenus *Larvaria*



B *Neomeris* subgenus *Drimella*



C *Neomeris* subgenus *Neomeris*

Figs 1A–C Reconstruction of fossil species belonging to three subgenera of *Neomeris*. **A,** *Neomeris (Larvaria) assurbanipali* Elliott nov. comb.; **B,** *Neomeris (Drimella) drimi* Radoicic 1984; **C,** *Neomeris (Neomeris) cretacea* Steinmann 1899. On the right, the relationships (not to scale) of the primary lateral (R_1; broken lined circles), ampulla (A; grey circles) and two secondary laterals (R_2; white circles) are shown.

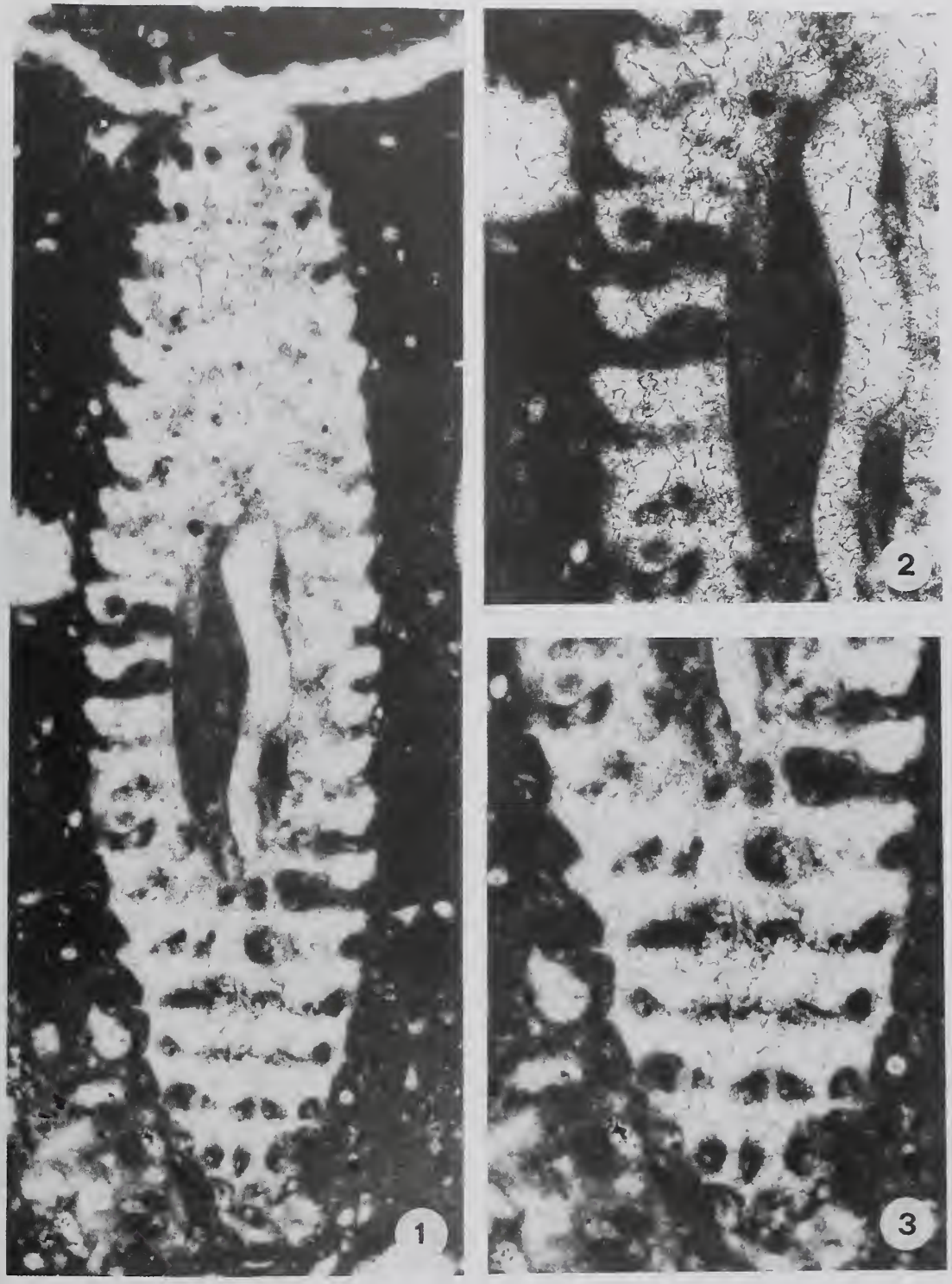


PLATE 1

Fig. 1 *Neomeris (Larvaria) assurbanipali* Elliott *nov. comb.* Oblique section. Lower Cretaceous (Valanginian – Hauterivian), Garagu formation, Erbil Liwa, Iran; V.52032, × 34.

Fig. 2 *Neomeris (Larvaria) assurbanipali* Elliott *nov .comb.* Detail of the left side of Fig.1, showing the ampulla set on distal end of a primary lateral. Note the secondary lateral set beneath the fertile ampulla. Lower Cretaceous (Valanginian – Hauterivian). Garagu formation, Erbil Liwa, Iran, V.52032, × 54.

Fig. 3 *Neomeris (Larvaria) assurbanipal* Elliott *nov. comb.* Detail of the lower part of Fig.1, showing the tufts of two phloiophorous laterals making a sort of cortex at the periphery. Lower Cretaceous (Valanginian – Hauterivian), Garagu formation, Erbil Liwa, Iran; V.52032, × 48.

In 1913, Leon & Jean Morellet added greatly to our knowledge of Tertiary fossil species of *Neomeris* and related forms. Their work was based on a rich microflora collected by Munier-Chalmas from the Paris Basin at the end of the 19th century. In addition to documenting new fossil material, they established several neomerid genera (e.g. *Larvaria, Vaginopora, Meminella*) that were later considered as junior synonymous of *Neomeris* (Génot 1980). Deloffre & Génot (1982) gave the following description of *Neomeris*: 'Two orders of branches. Each primary branch bears one fertile ampulla and two (sometimes three in living *Neomeris*) secondary branches. These are set on both sides of the fertile ampulla (*Neomeris s.s.*) or set in a plane located beneath the plane containing fertile ampullae (sub-genus *Larvaria*)'.

Later, Radoicic (1984) established the new subgenus *Drimella*, based on a Late Cretaceous species from Serbia, and gave the following diagnosis: '*Neomeris* with secondary branches laterally located on one side of the fertile ampulla, on vertical or more or less oblique plane. In adjacent verticils, secondary branches can be arranged: in one on the same, and in another on the opposite side of the fertile ampulla, or in each verticil on the same side'.

The subdivision into three subgenera (*Neomeris*, *Larvaria*, *Drimella*) was confirmed by Génot (1987). Their structural organisation is illustrated in Fig. 1.

Phylum **CHLOROPHYTA** Pascher, 1914
Class **CHLOROPHYCEAE** Kützing, 1843
Order **DASYCLADALES** Pascher,1931
Family **DASYCLADACEAE** Kützing, 1843
Tribe **NEOMEREAE** Pia, 1920; emend. Bassoullet *et al.*, 1979
Genus ***NEOMERIS*** Lamouroux, 1816; emend. Deloffre, 1970

Neomeris assurbanipali Elliott, nov. comb.

1968 *Acroporella assurbanipali* Elliott: 18, pl. 1, fig. 5.

HOLOTYPE. V.52032 (1), slide.

HORIZON AND LOCALITY. Lower Cretaceous, Valanginian/Hauterivian. Garagu Formation. Well no.116, Kirkuk, Iraq.

REFERRED MATERIAL. G. F. Elliott Colln., presented 1966.

DESCRIPTION. The character of the species can be deduced from the single specimen in oblique section (pl. 1 fig. 2). Assessment of

Table 1 Main biometrical parameters of *Neomeris assurbanipali* Elliott *nov. comb.* All size parameters are given in mm. ***d***: inner diameter of the calcareous skeleton; ***D***: outer diameter of the calcareous skeleton; ***e***: thickness of the calcareous wall; ***pv***: vertical width of primary laterals; ***pvd***: vertical width of primary laterals at their distal end; ***l***: length of primary laterals; ***w***: number of primary laterals per whorl; ***h***: distance between two subsequent whorls; ***p'***: width of secondary laterals; ***l'***: length of secondary pores; ***da***: diameter of the ampulla.

	This paper	From Elliott, 1968
d	0.55	0.55
D	1.4	1.36
e	0.43	
pv	0.16 – 0.20	0.182
pvd		0.156
l	0.25	0.78
w	11 – 12	12
h	0.23 – 0.25	
p'	0.010 – 0.012	
l'	0.20	
da	0.11	

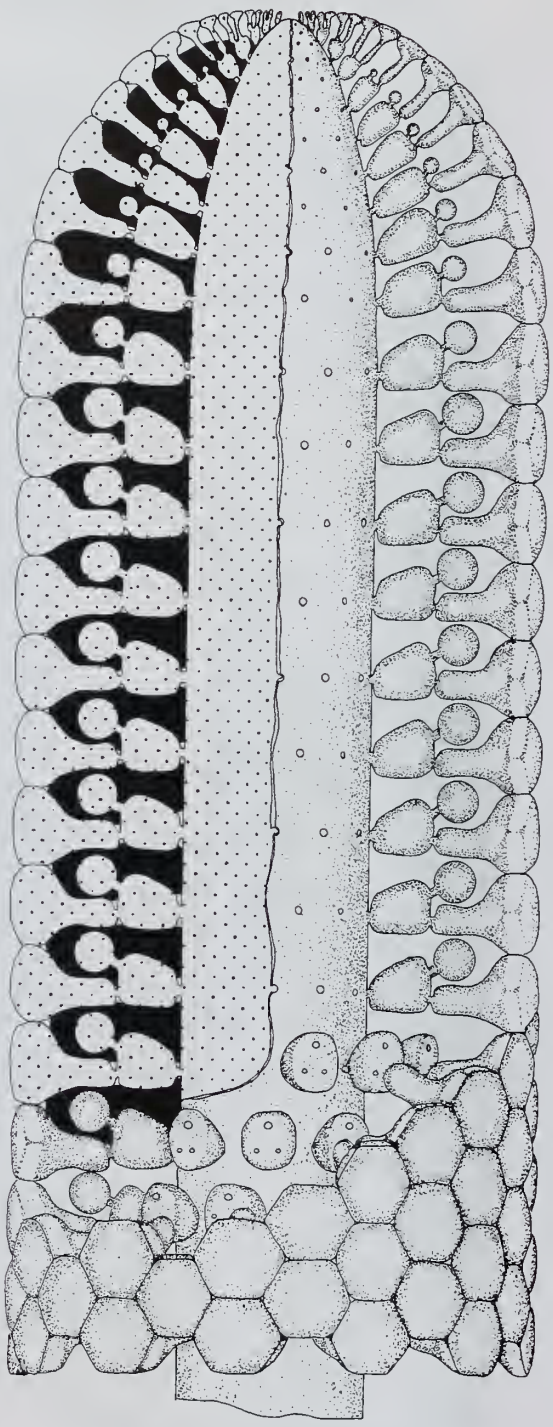


Fig. 2 *Neomeris (Larvaria) assurbanipali* Elliott nov. comb. Longitudinal reconstruction of the thallus. Left side: central siphon, primary laterals, secondary laterals, ampullae and calcification (in black) in axial section. Right side: perspective view of the primary laterals, secondary laterals, ampullae and central siphon deprived of calcification. On the left frontal part only the junction of the laterals and the ampullae are drawn. At the base is a perspective view of the cortex built from the secondary laterals drawn in hexagonal meshes (× 45).

the variability of the species and some qualitative characters such as the shape of thallus, laterals and reproductive organs would have required more abundant material.

The thallus is apparently cylindrical and simple. Primary laterals are arranged in moderately close whorls. Their position between whorls, alternated or in continuity, is not evident. However they are phloiophorous and rather strong, almost perpendicular to the stem axis. The transverse section of the primary pores is rectanglar in the middle part and square in the distal part. The number of primary laterals per whorl can be estimated as 11–12. This value corresponds well with that supplied by Elliott.

Two strong secondary laterals originate from the distal end of each primary lateral. They show a subcylindrical inner part of modest length, 0.11–0.12 mm, and 0.10–0.12 mm in diameter, followed by a part that flares out quickly, so making a cortex at their distal end (pl.1, fig. 3). The two secondary laterals are nearly placed on an horizontal plane, i. e. parallel to the verticillar plane.

Elliott did not identify the twofold laterals, but he interpreted the shape of primary and secondary laterals in longitudinal section as parts of a single lateral. He correctly described the first inner part (primary) as 'a fig- or flask-shaped cavity', and the second outer part (secondary lateral) as 'a slightly curved tube'.

The holotype occasionally shows structures referable to reproductive organs (ampullae: pl.1, fig. 2). The ampulla is set at the distal end of each primary lateral, over the plane where the secondary laterals are placed. It is of spherical shape, 0.11 mm in diameter, joined to the primary lateral probably by means of a short peduncle. The difficulty in observing the reproductive organs can be explained by the fact that most of them were empty and were destroyed after the re-crystallisation of the aragonitic calcareous skeleton. Only those filled by matrix have a chance of being preserved and recognised in thin section.

The calcification consists of a strong calcareous skeleton. It envelopes the primary laterals, the ampullae and the secondary laterals up to their swollen distal end corresponding to the inner edge of the cortex. The smooth and regular inner cavity indicates that calcification probably reached the wall of the central stem. Moreover, in this area the primary laterals open with a reduced pore.

The main biometrical values of the alga are given in Table1.

PALAEONTOLOGICAL RECONSTRUCTION

The reconstruction in Figs. 2 and 3 takes into account the biometrical values and the morphological characters previously given. The number of pores in a whorl has been chosen to be twelve, and a cortex of hexagonal meshes set horizontally has been supposed. The latter seems to be the most likely arrangement for that number of pores in a whorl and the distance between whorls.

Considering the apex of the thallus, no elements can be deduced from the single specimen at our disposal, and therefore it has been drawn by inference from extant species of *Neomeris* (e.g., *N. annulata*).

TAXONOMIC ATTRIBUTION

The species is attributed to the genus *Neomeris* from the evidence of primary laterals in verticils that bear distally two secondary laterals and an ampulla. The fact that the species exhibits two secondary laterals arranged in an horizontal plane beneath an ampulla, allows us to refer *N. assurbanipali* to the subgenus *Larvaria*. The species, if compared with others of the same genus, shows such a combination of characters as to maintain the taxonomical validity. In addition *Neomeris (Larvaria) assurbanipali* differs strikingly from all the other counterparts by having a calcareous skeleton that envelops the primary laterals entirely, and seemingly reaches the central stem.

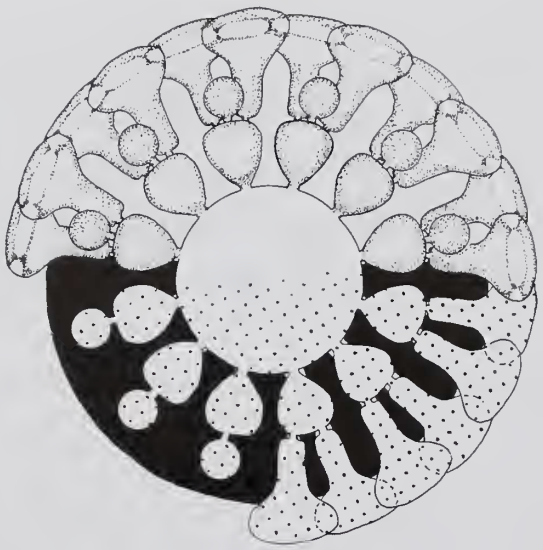


Fig. 3 *Neomeris (Larvaria) assurbanipali* Elliott nov. comb. Transverse reconstruction of the thallus. Upper half: part of a verticil showing the central siphon, primary laterals, secondary laterals and ampullae without calcification. Lower half, right: transversal section through the primary and secondary laterals, calcification in black. Lower half, left: transversal section through the primary laterals and ampullae, calcification in black (× 45).

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